Day/Night MODIS Cloud Analyses

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Topics:

- Correlation of two independent products (cloud temperature & phase)
- Investigation of spatial resolution effects
- Initial comparisons of MODIS phase results with ARM CART site data

Algorithms

Cloud thermodynamic phase:

Based on IR trispectral method: 8.5, 11, 12 um bands

Results are derived for 5x5 pixel averages of 1-km data

Cloud height/temperature

Based on CO_2 slicing technique

Uses pairs of bands in 15-μm CO_2 band

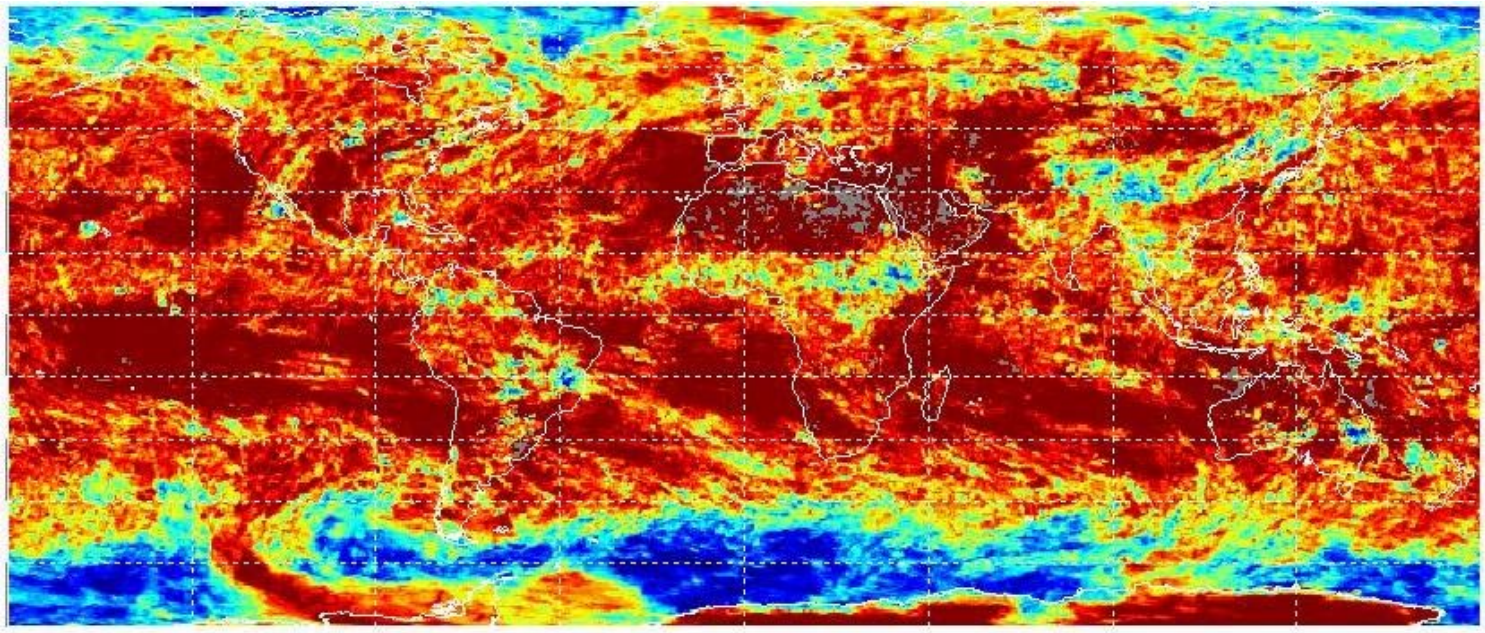
Cloud temperature determined based on GDAS gridded product

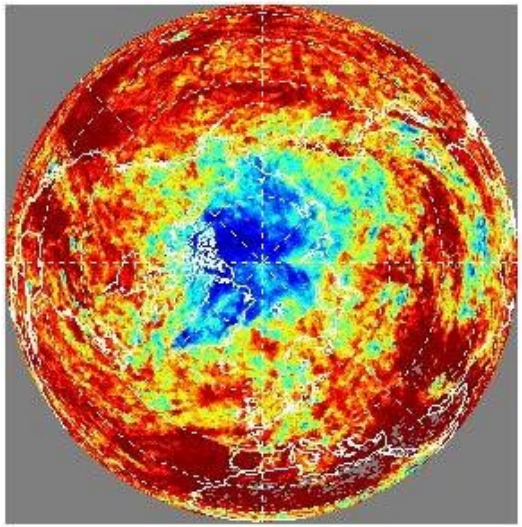
Global cloud phase retrieval

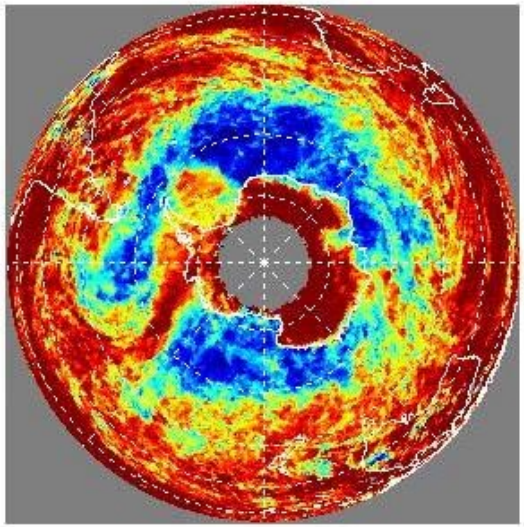
How much of the time is the cloud thermodynamic phase retrieval certain of either ice or water with an IR-only approach?

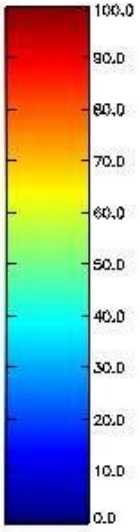
Percentage of the time where the retrieved phase is either ice or water (mixed or uncertain phase excluded)

Results from 4 days of daytime-only data



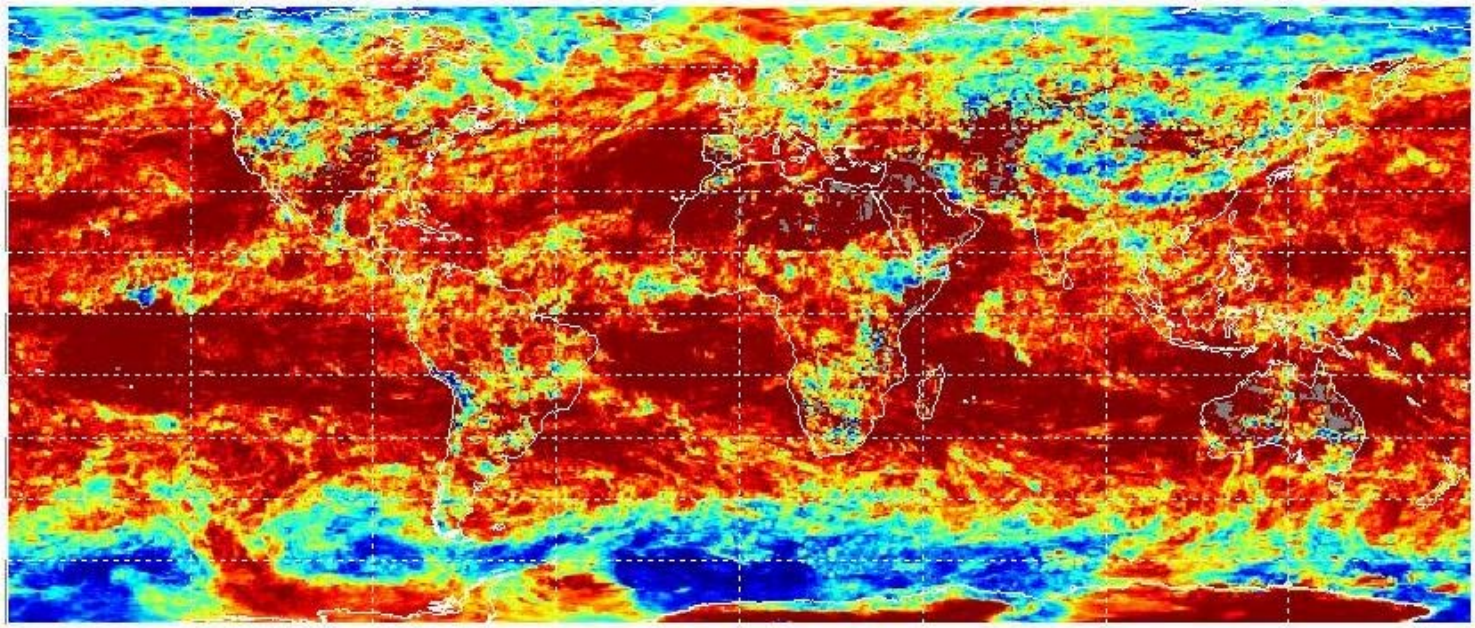


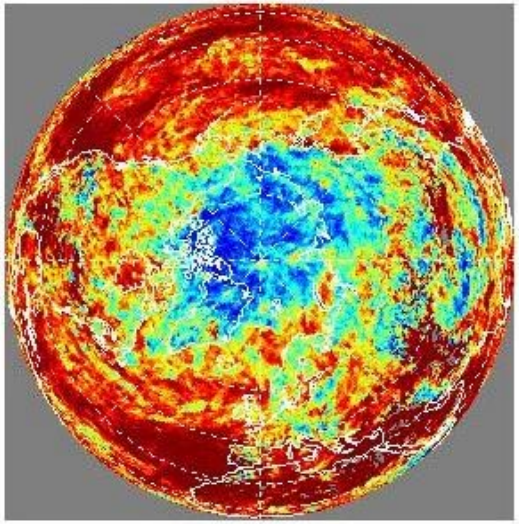


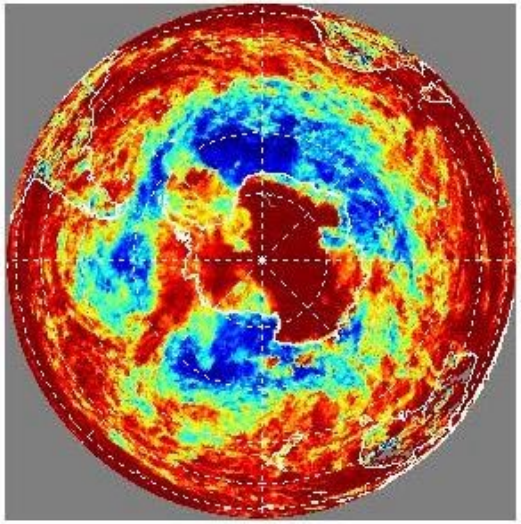


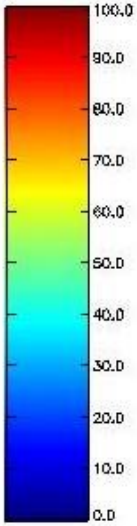
Percentage of the time where the retrieved phase is either ice or water (mixed or uncertain phase excluded)

Results from 4 days of nighttime-only data









Global cloud phase - cloud temperature correlations

Three temperature regimes:

$T_c < 243$ K

$243 \text{ K} < T_c < 273$ K

$T_c > 273$ K

Four phase classifications:

Ice

Water

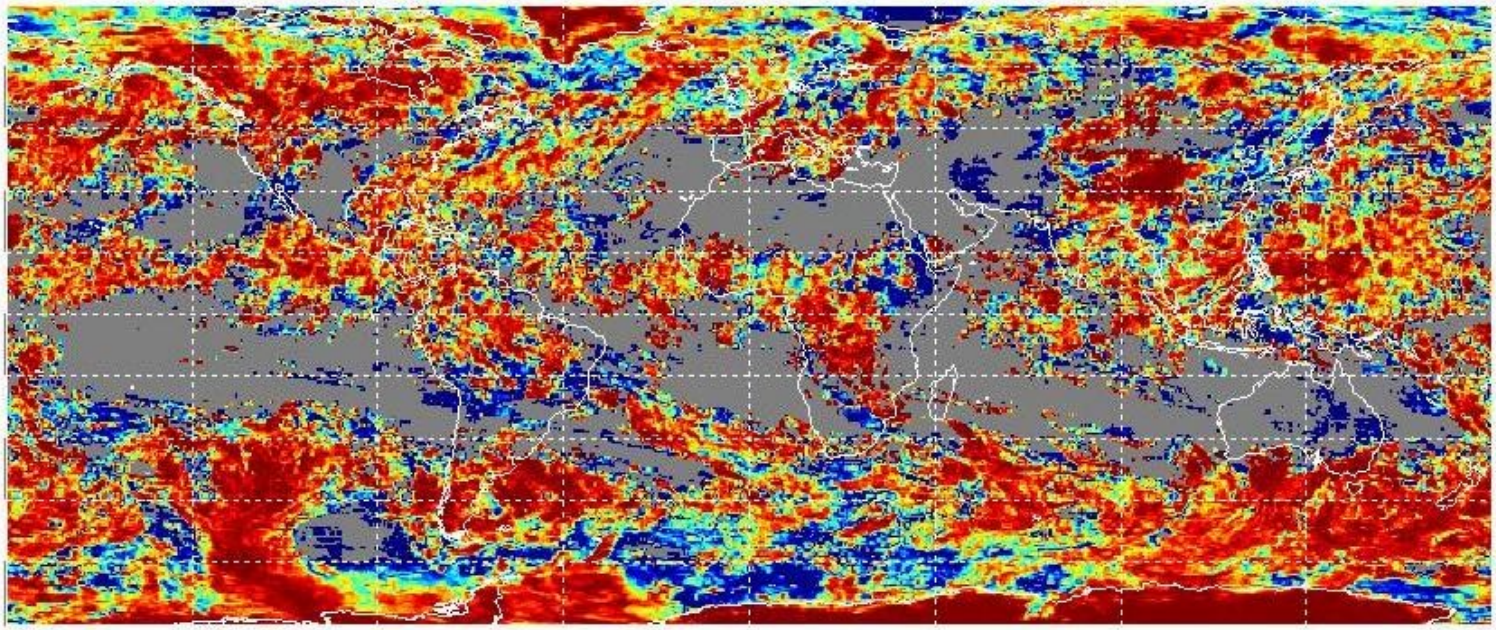
Mixed

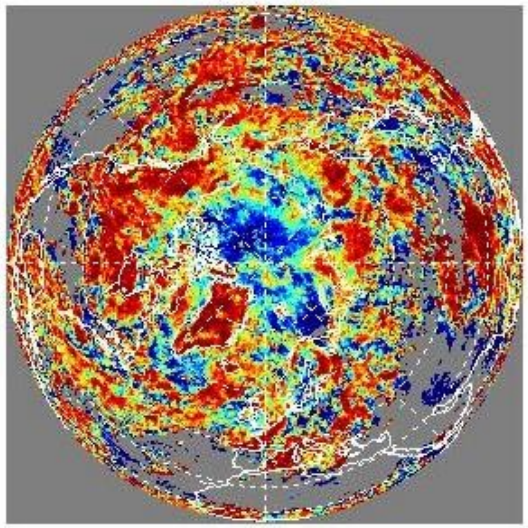
Uncertain

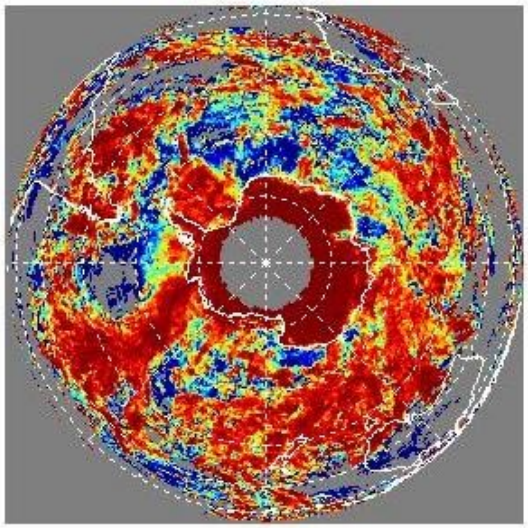
Separation of Day/Night

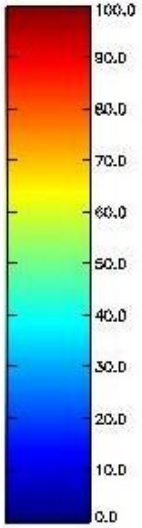
Correlation of ice phase with $T_c < 243K$

Results from 4 days of daytime-only data



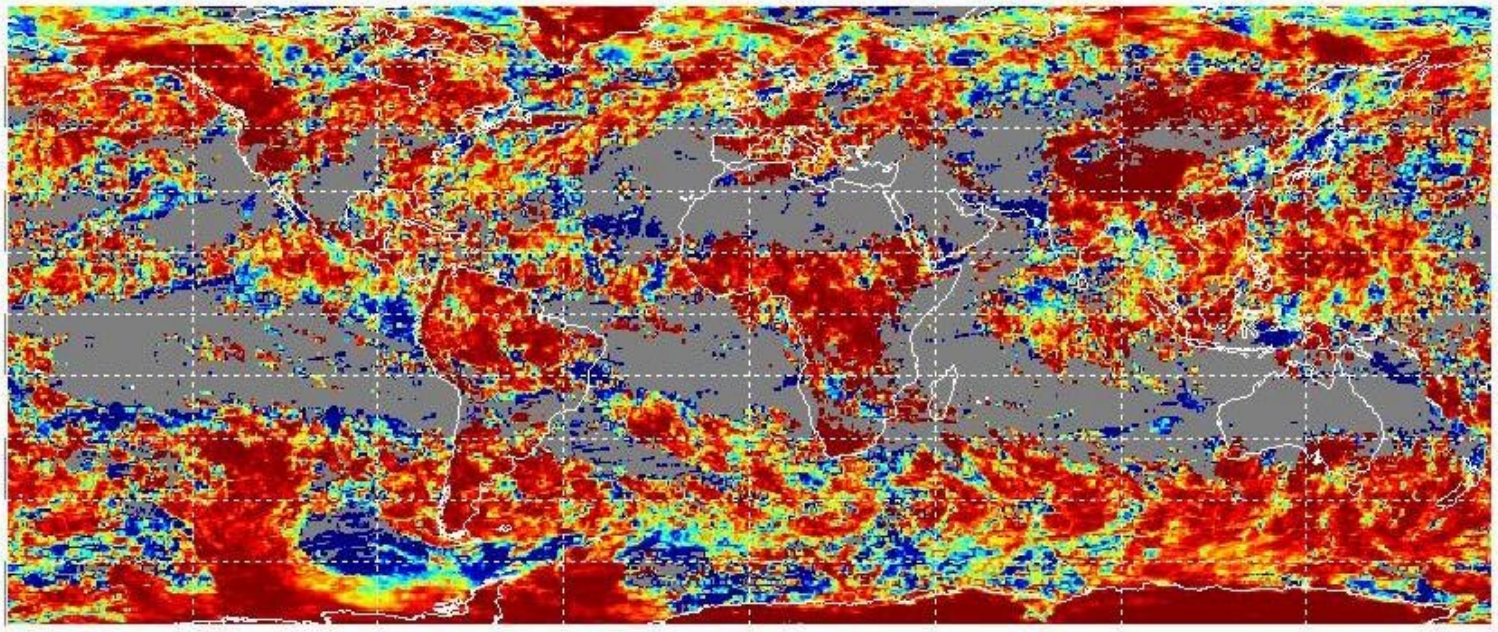


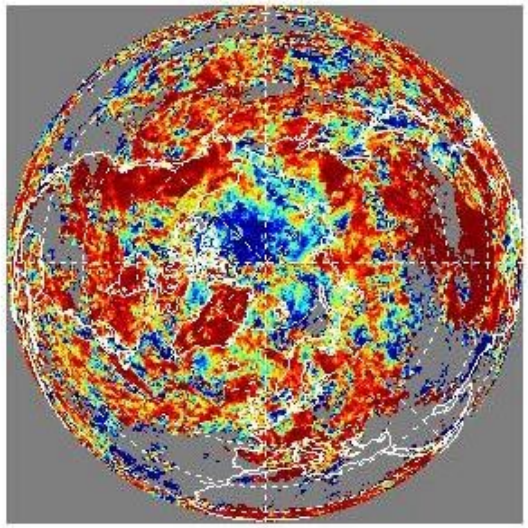


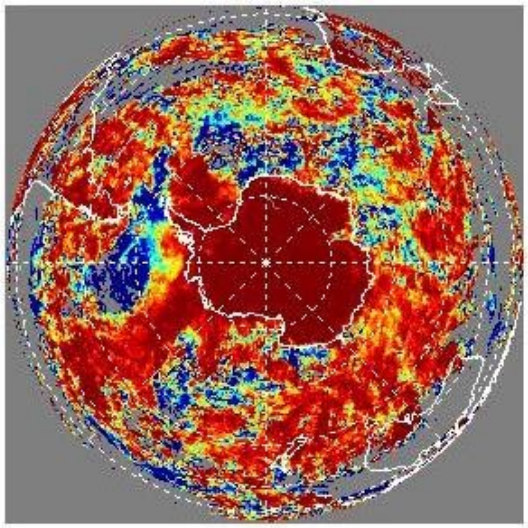


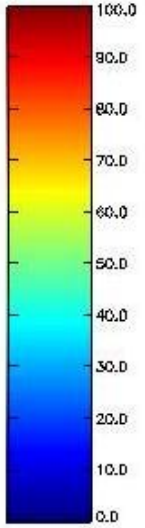
Correlation of ice phase with $T_c < 243K$

Results from 4 days of nighttime-only data



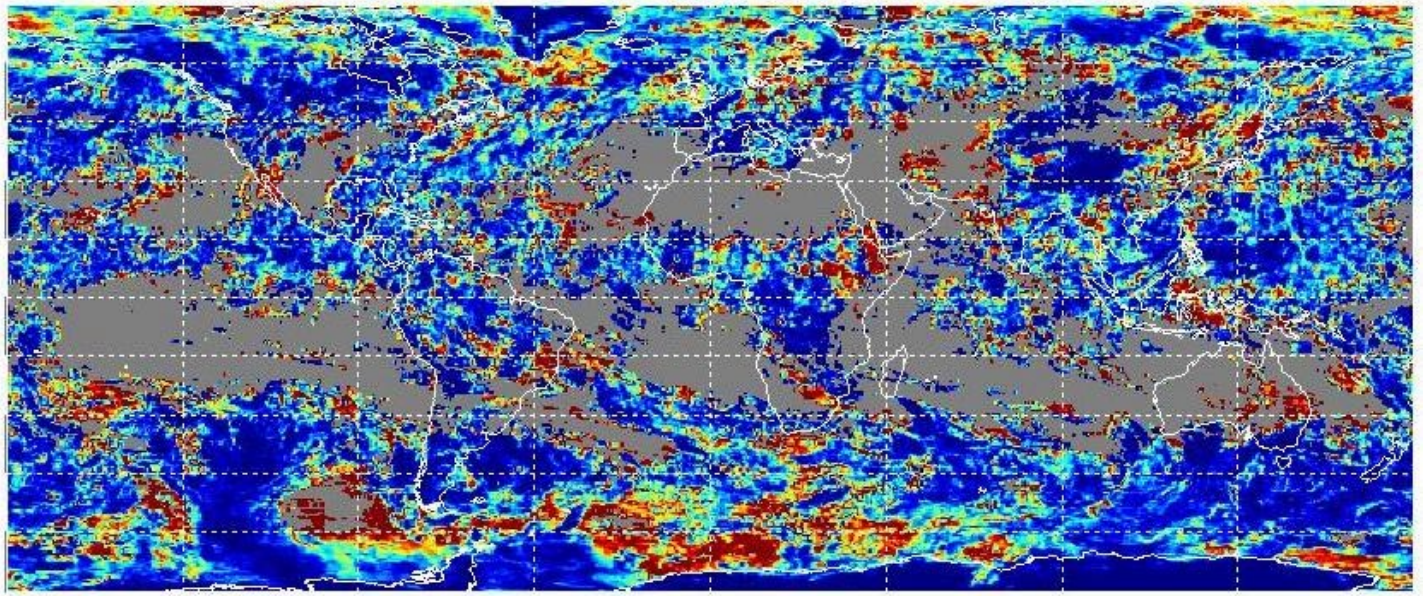


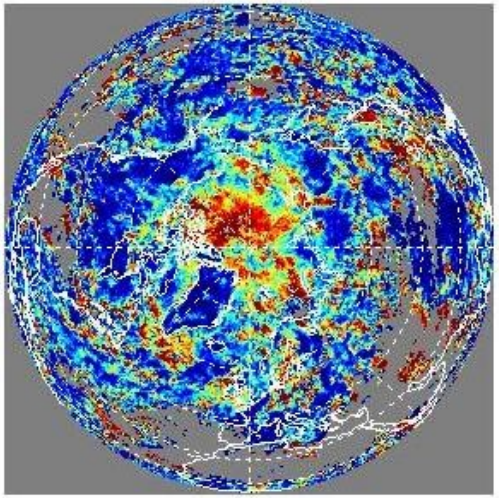


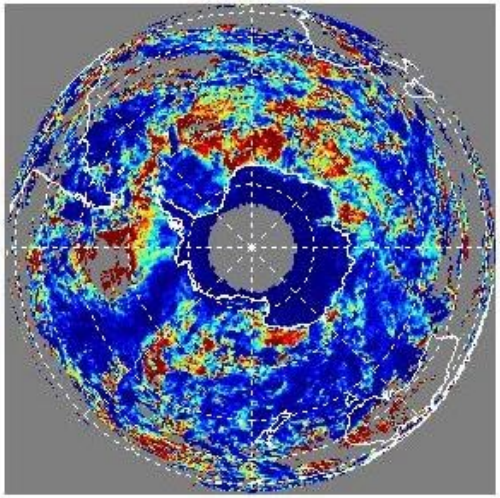


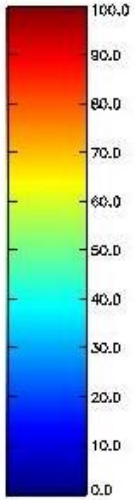
Correlation of ice phase with $243K < T_c < 273K$

Results from 4 days of daytime-only data



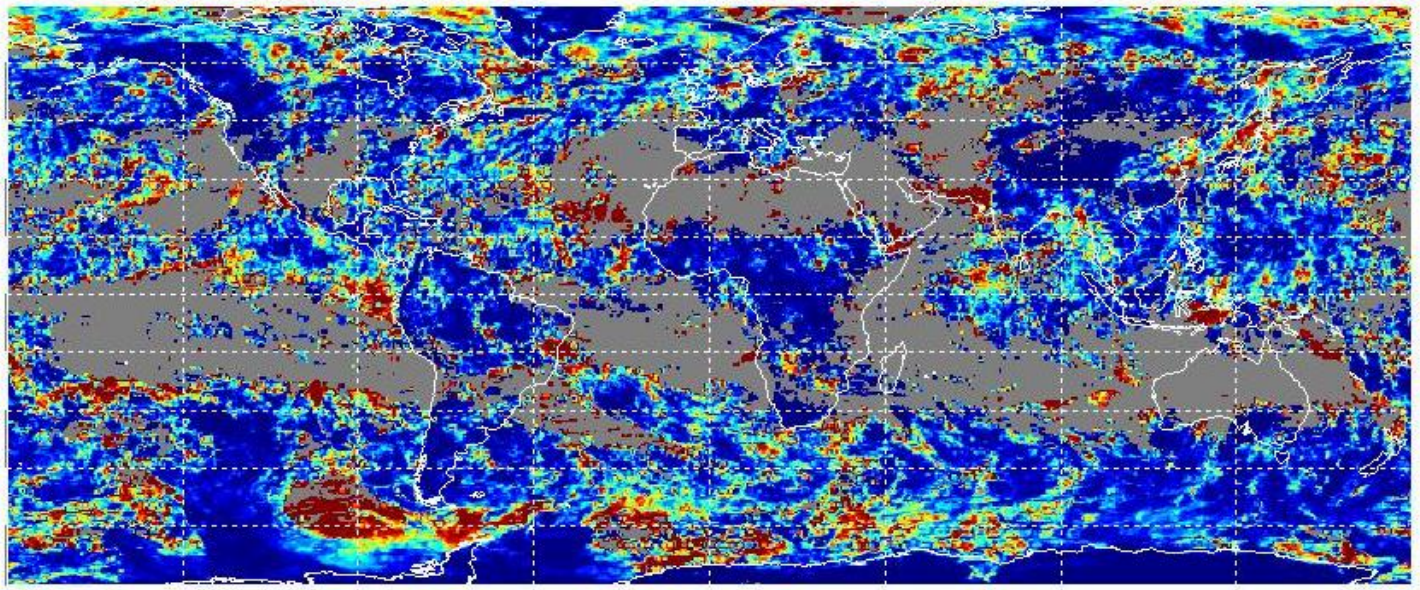


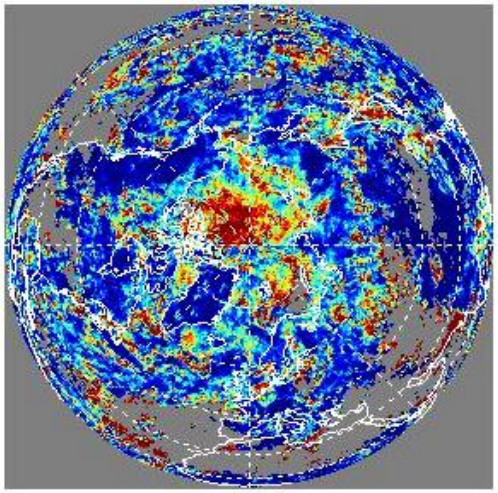


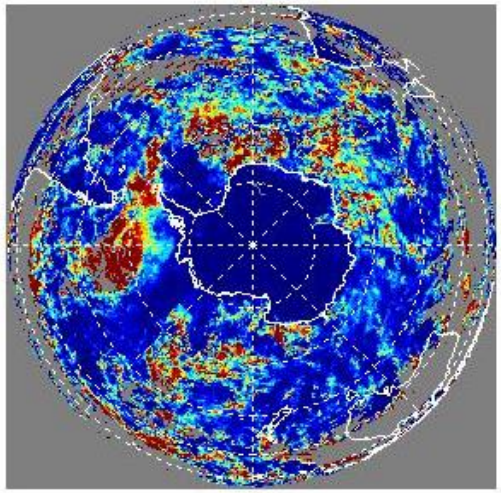


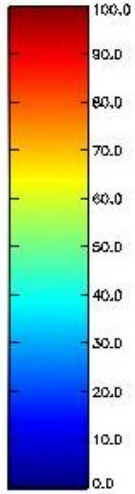
Correlation of ice phase with $243K < T_c < 273K$

Results from 4 days of nighttime-only data



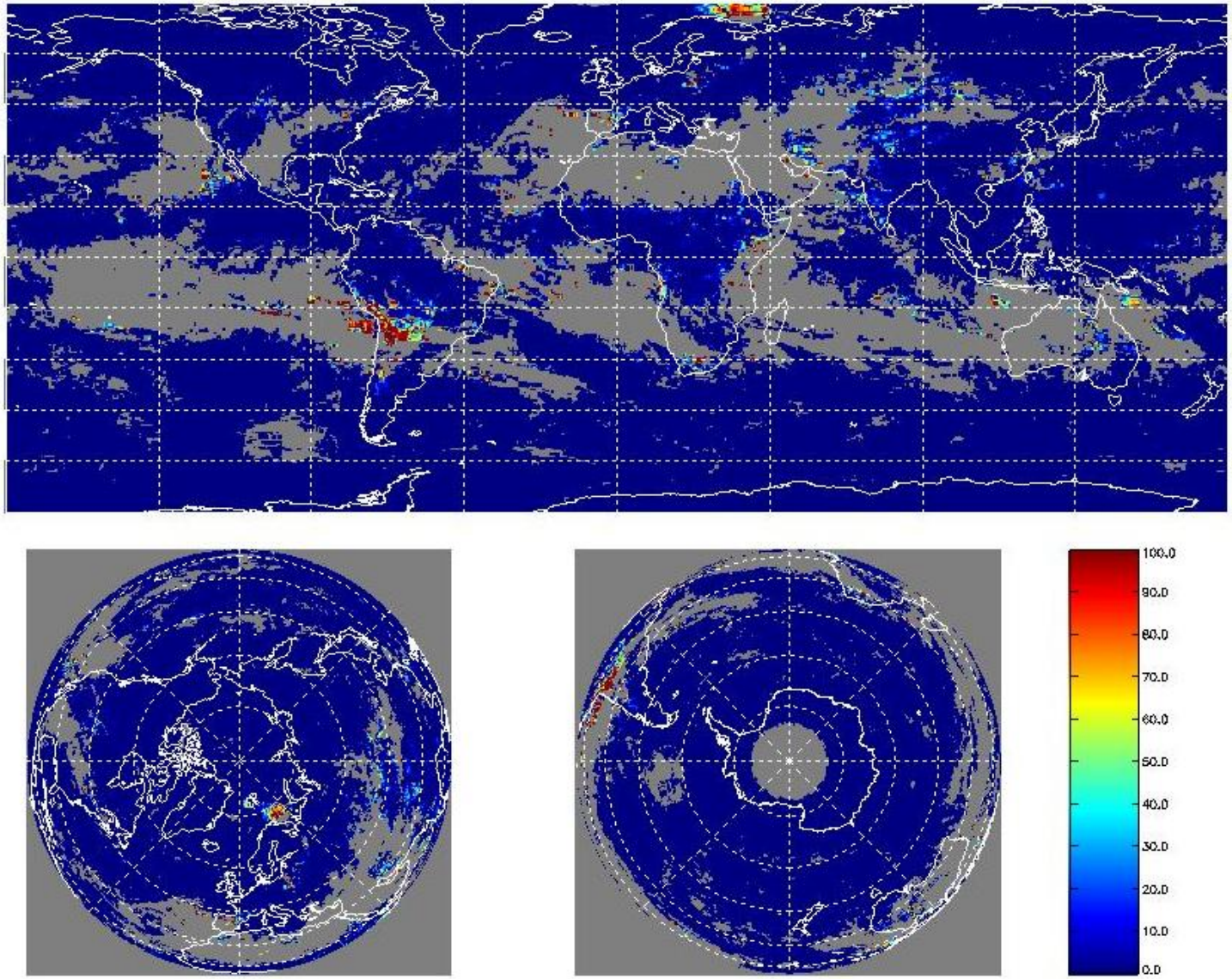






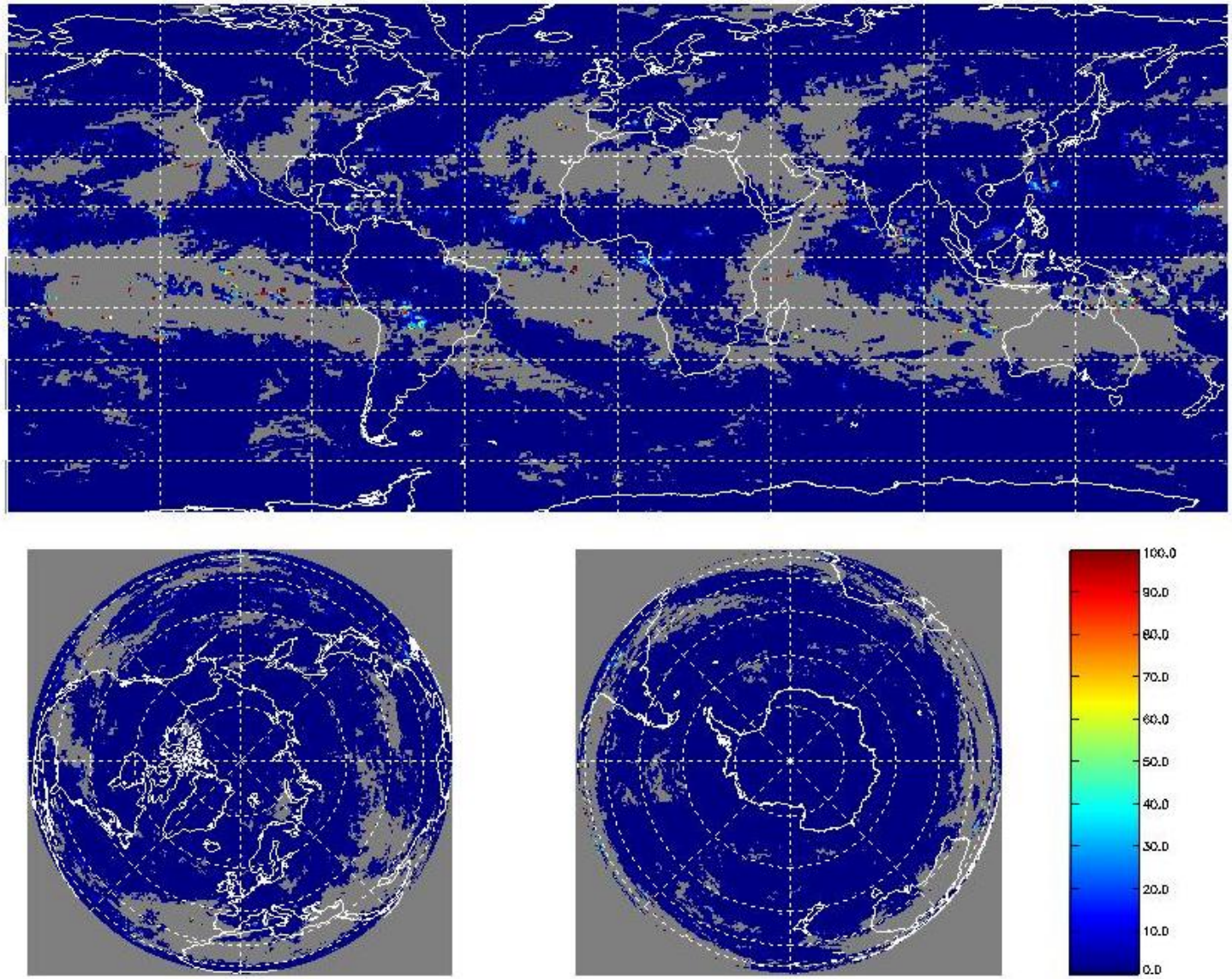
Correlation of ice phase with $T_c > 273K$

Results from 4 days of daytime-only data



Correlation of ice phase with $T_c > 273K$

Results from 4 days of nighttime-only data



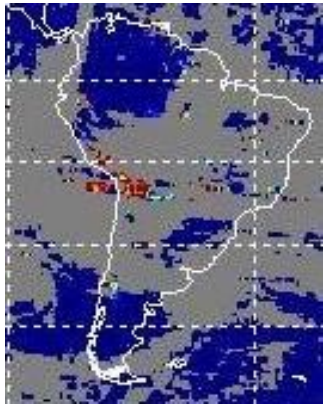
Global cloud phase - cloud temperature correlations

Take a closer look at specific regions for the two correlations that provide the most heartburn:

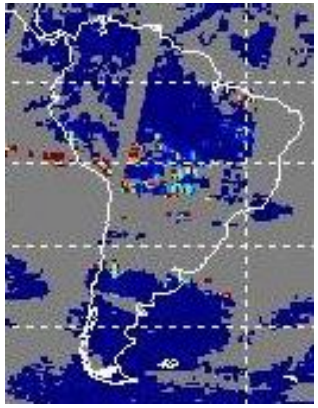
Ice phase clouds with $T_c > 273$ K : South America

Water phase clouds with $T_c < 273$ K : Africa

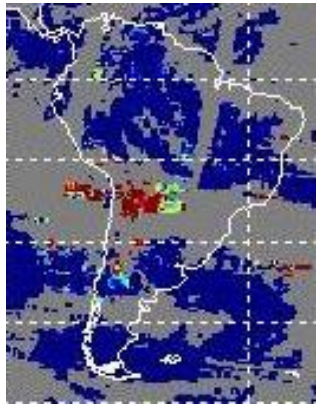
Correlation of ice phase with T_c > 273K
Daytime data



September 5

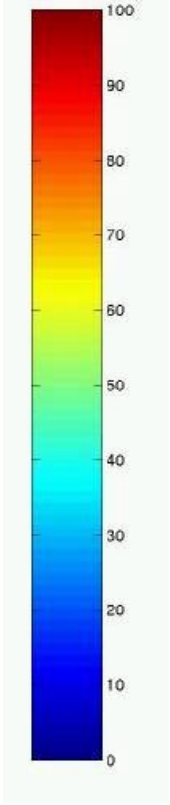


September 6

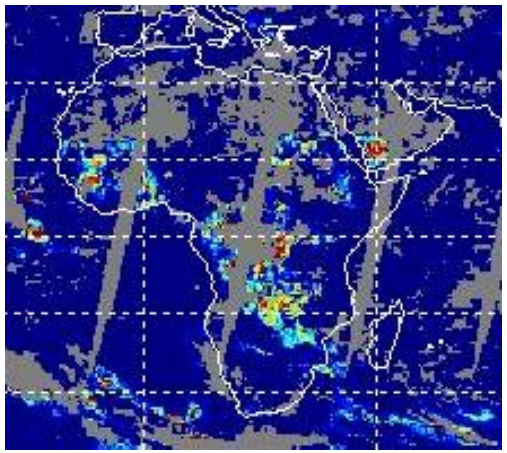


September 7

September 8



Correlation of water phase with T_c < 243K
Daytime data



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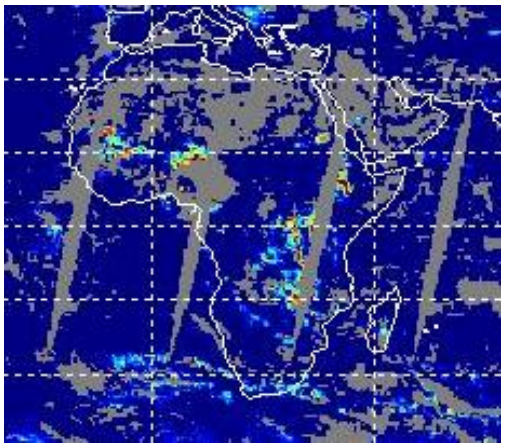

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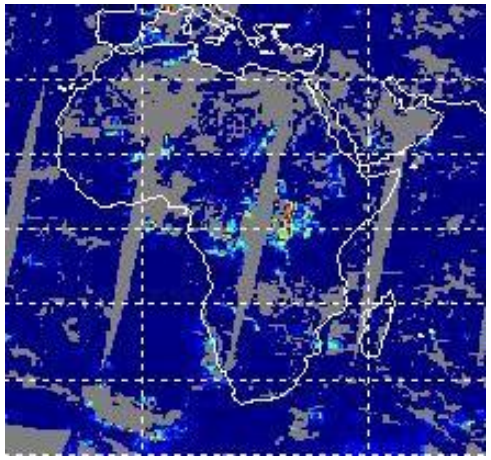
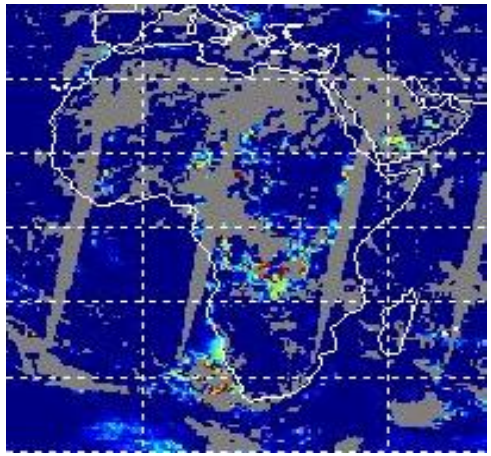


September 7



September 8

Summary of Cloud Thermodynamic Phase - Cloud Temperature Correlation Results

The IR methods are applied independently of each other:

- over all surfaces, including land, water, snow
- over all viewing angles for full swath data

Results in general are consistent between day and night

Need further investigation in central S. America, S. Africa, high-latitude storm tracks, mountainous terrain

High priority*: improving our understanding of mixed-phase clouds*

Should we modify our cloud phase discrimination based on cloud temperature?

Mixed Phase Clouds

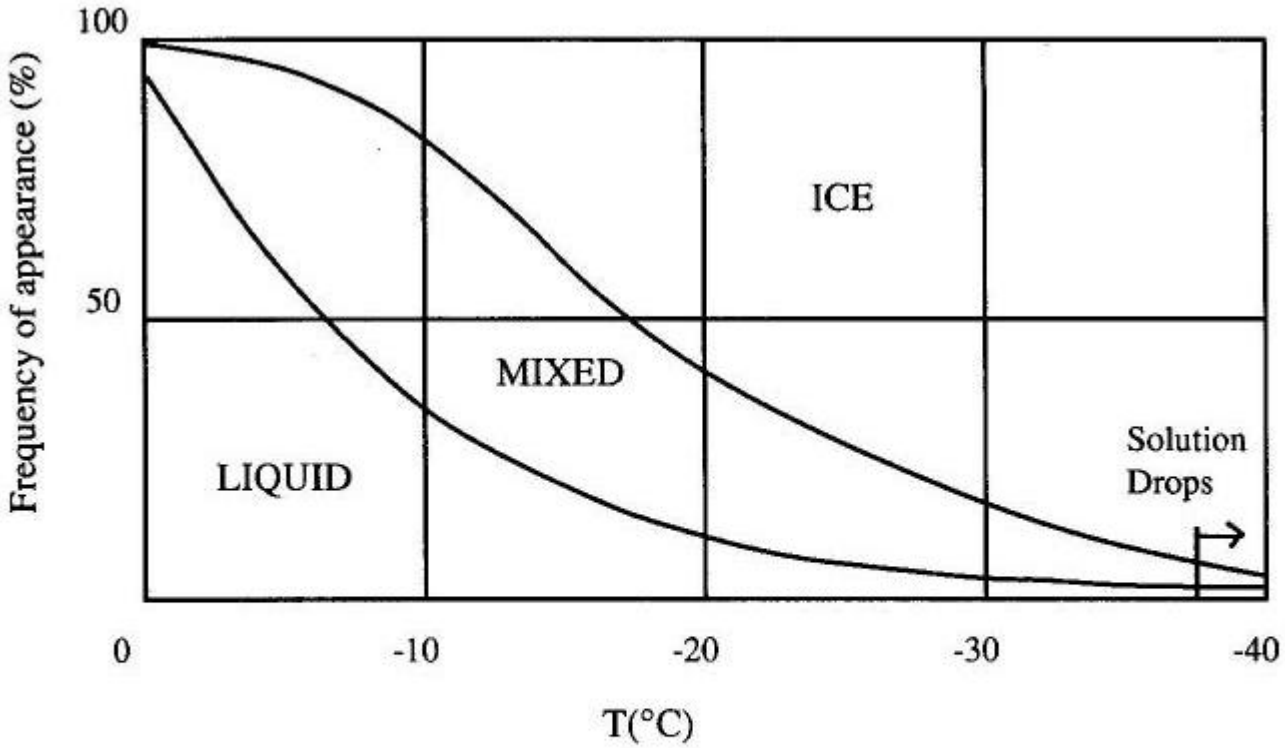
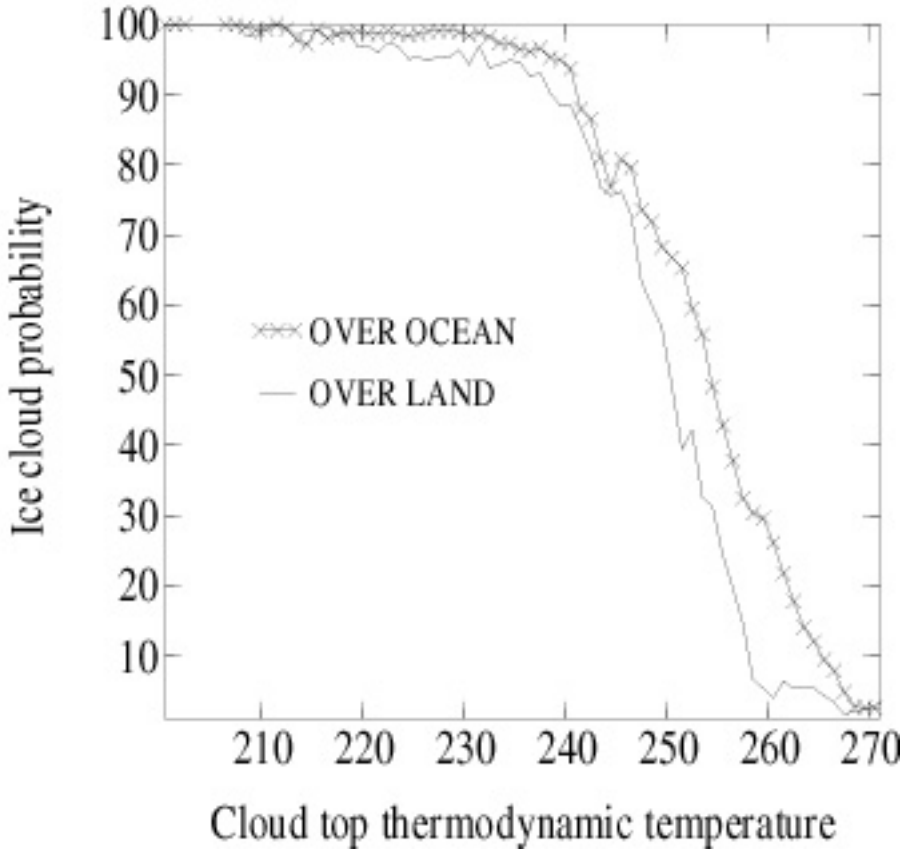


Figure 1 Average frequencies of appearance of the supercooled water, mixed-phase (water and ice), and all ice as a function of temperature in layer clouds over the European territory of the USSR. (After Borovikov et al., 1963.)

Comparison of POLDER (ADEOS-1) to ATSR-2 (ERS-2) on June 12, 1997

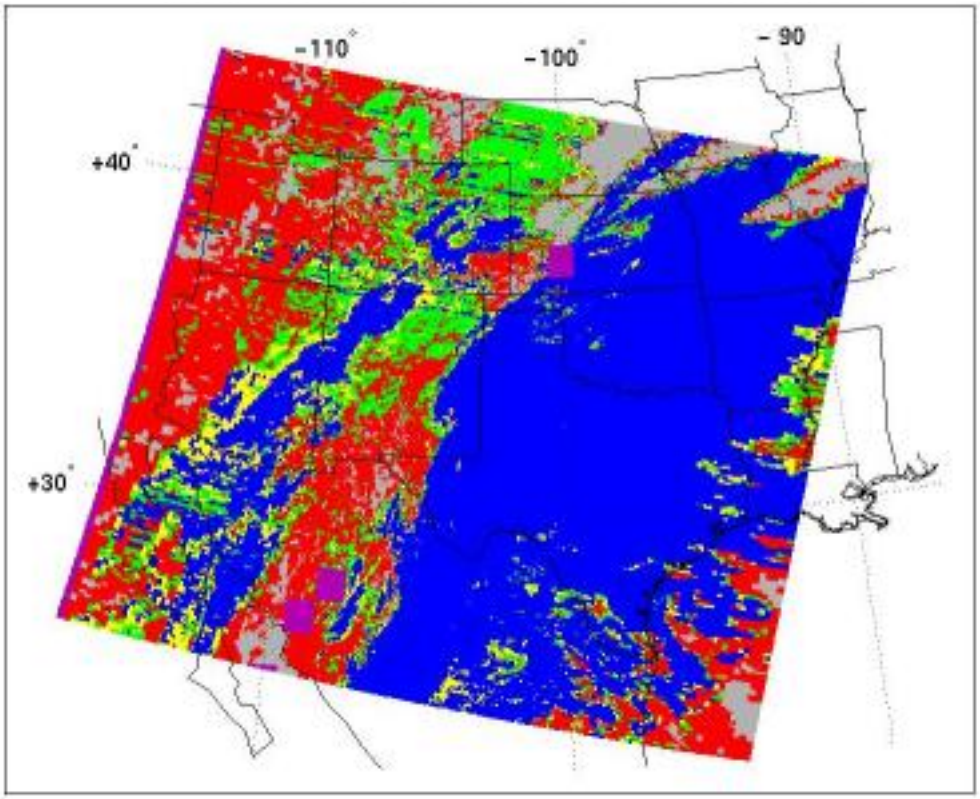


V. Giraud et al., Cloud top temperature and IR split window signature in relation with thermodynamic phase, submitted to G.R.L.

Comparison with ARM SGP Data

Comparison with UW HSRL, FARS, and CART sites is beginning

Have 2 examples to show of cloud phase comparisons with ARM CART SGP data for multilayered cloud conditions

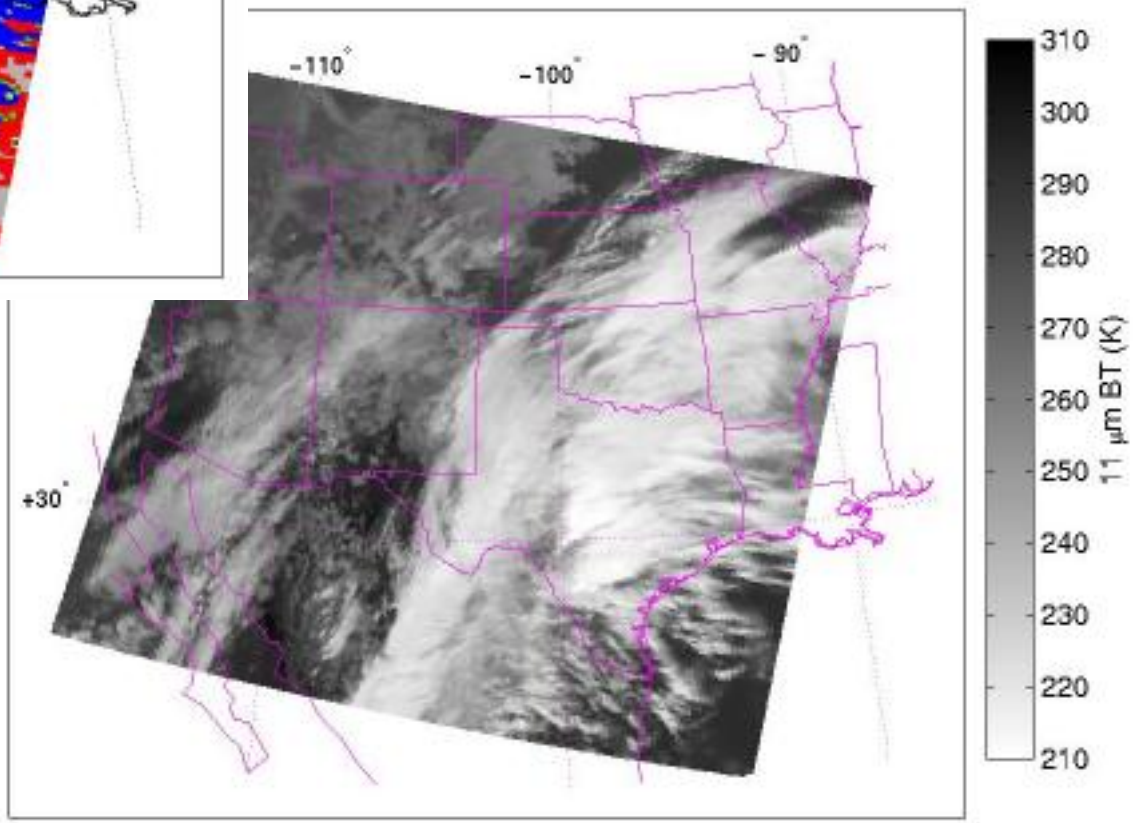


MODIS 03 Nov. 2000 at 17:55 UTC

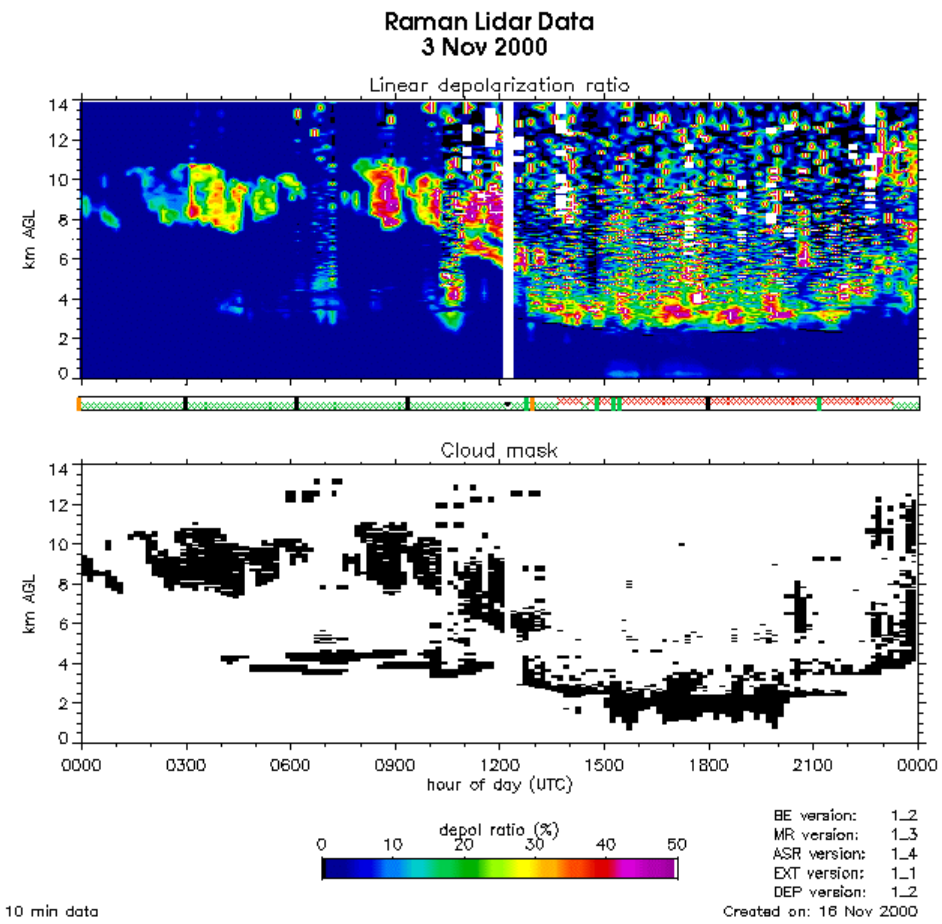
MODIS Phase Product

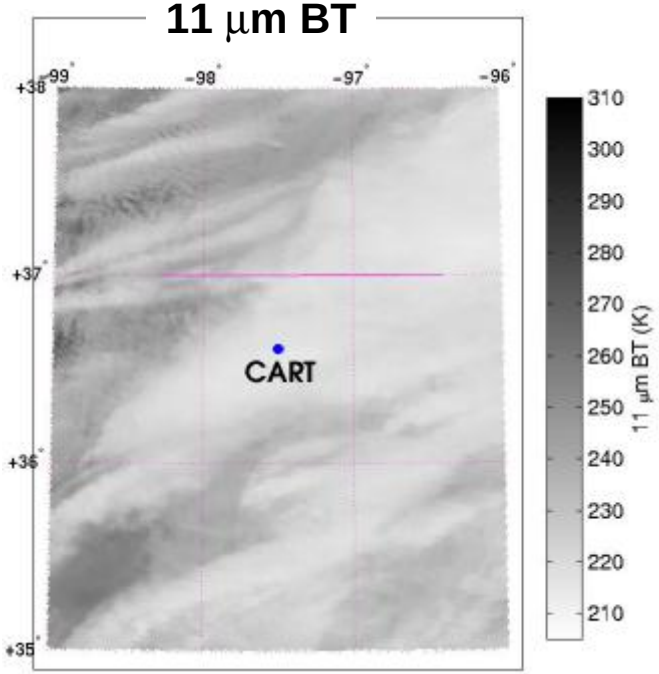
Ice *Mixed*

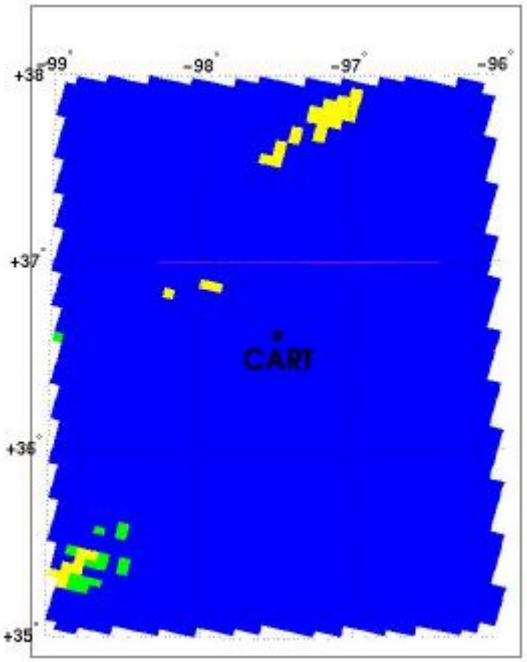
Water *Unknown*



MODIS Band 31
11 μm BT (K)

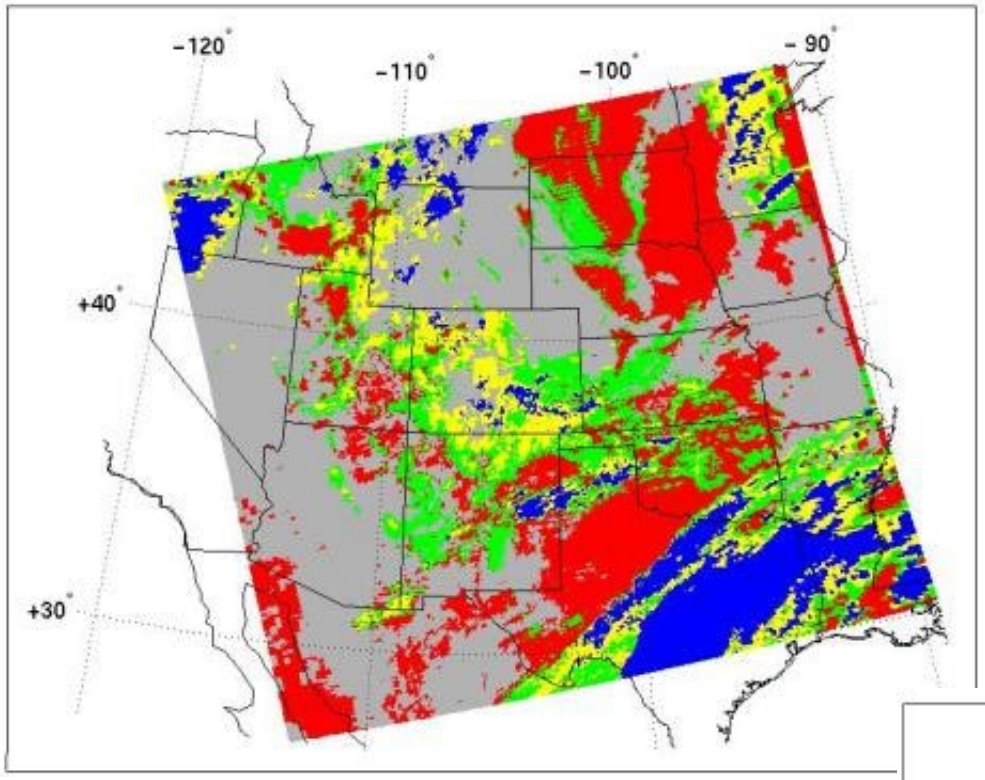






MODIS Phase Product around ARM CART site

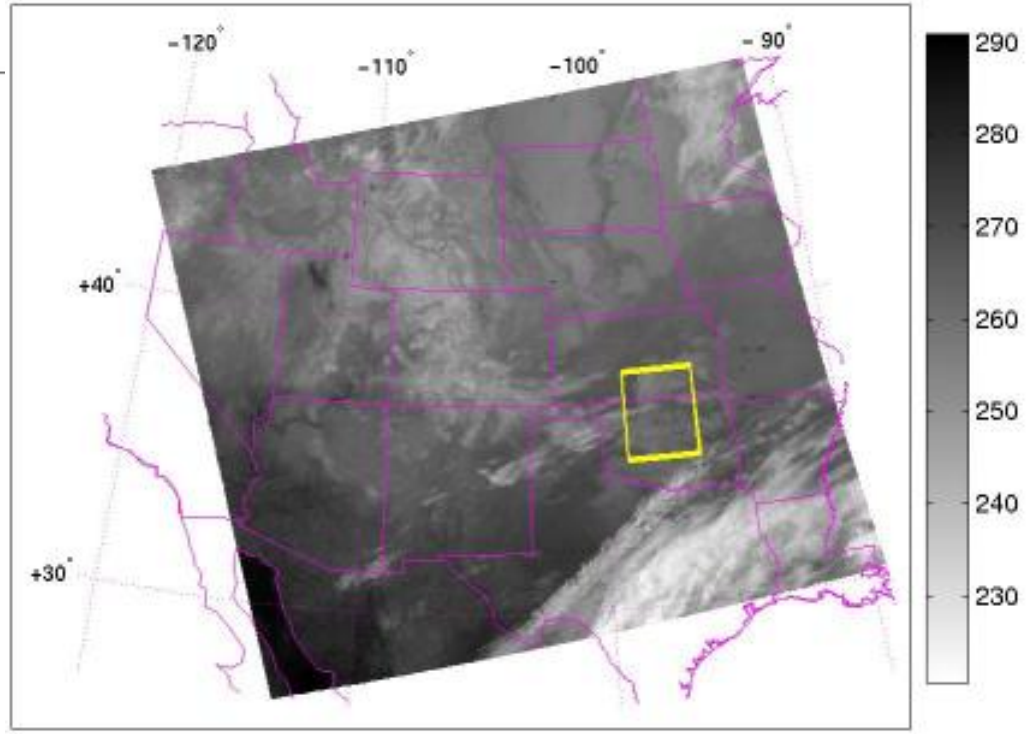
- *Ice*
- *Mixed*
- *Water*
- *Unknown*



MODIS 18 Nov. 2000 at 05:10 UTC

MODIS Phase Product

- *Ice*
- *Water*
- *Mixed*
- *Unknown*



MODIS Band 31
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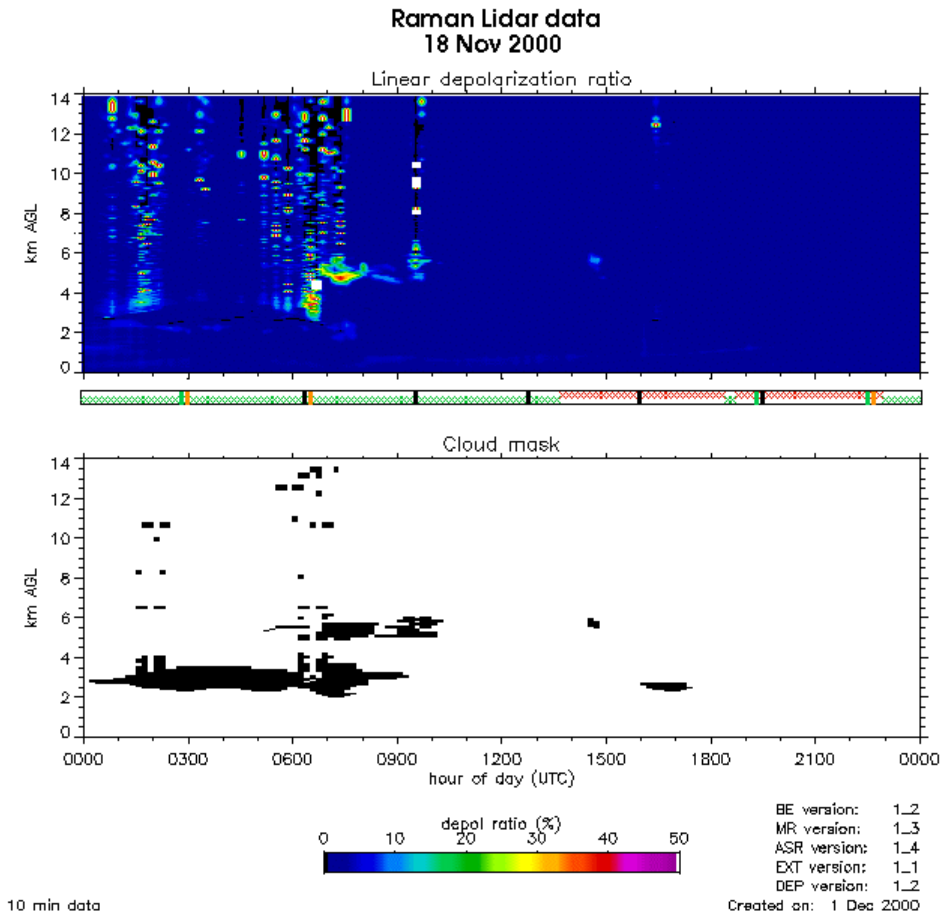
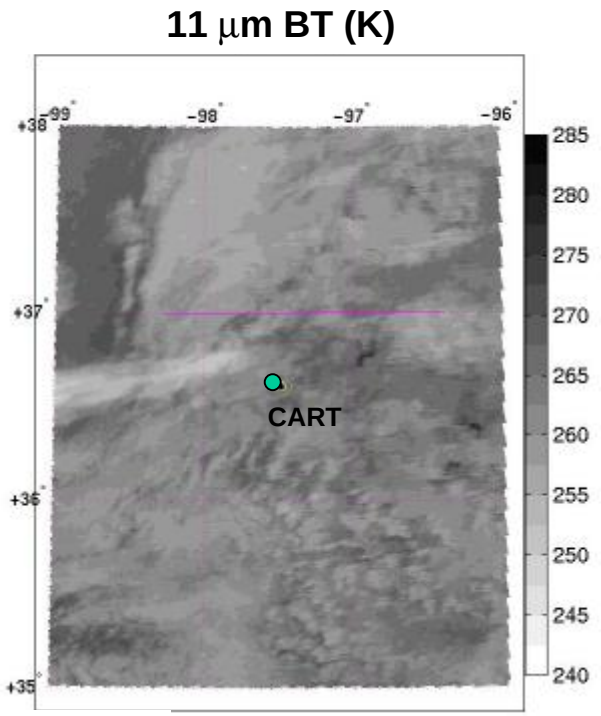
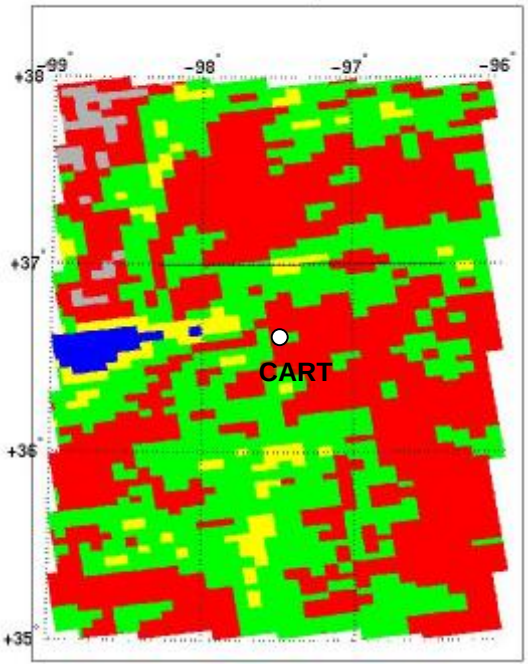






MODIS Phase Product around ARM CART site

Ice *Mixed*

Water *Unknown*

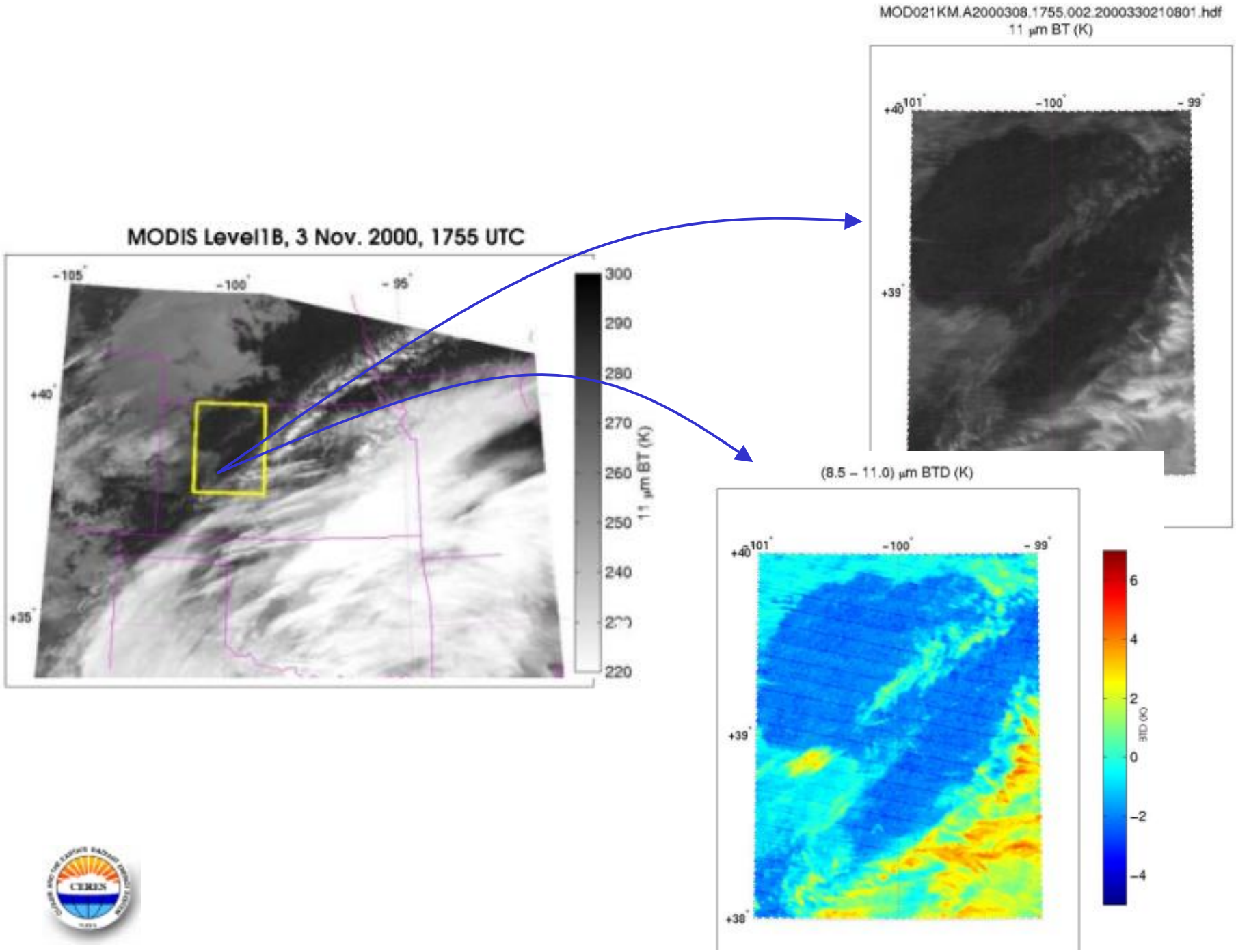
Spatial Resolution Effects

CERES has indicated interest in having a 1-km cloud phase retrieval code

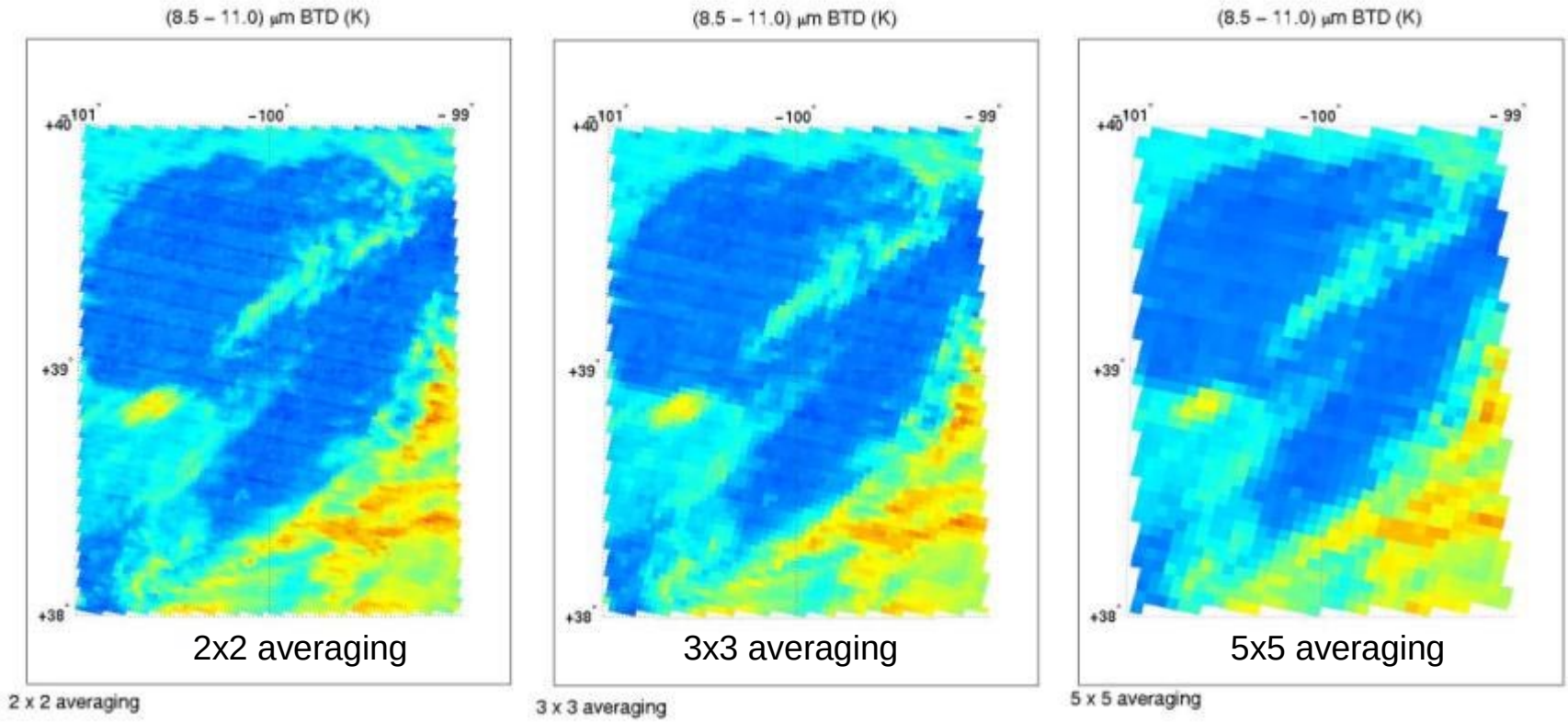
The MODIS IR trispectral method operates on a 5x5 array of pixels and includes both spatial and spectral tests

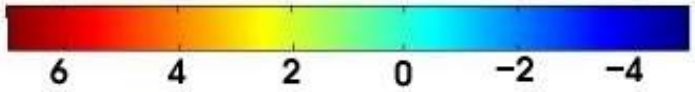
Tests were performed to evaluate a “simpler” version of the cloud phase algorithm, based solely on the 8.5 & 11-μm bands

Problem: run into instrument detector issues that seem to be apparent with BTDs


MODIS Level1B, 3 Nov. 2000, 1755 UTC
-105°
-100°
-95°
+40°
+35°
300
290
280
270
260
250
240
220
11 μm BT (K)
MOD021KM.A2000308.1755.002.2000330210801.hdf
11 μm BT (K)
101°
-100°
-99°
+40°
+39°
(8.5 – 11.0) μm BTD (K)
+38°
6
4
2
0
−2
−4
BTD (K)

Spatial Resolution Effects - BTD[8.5-11 μm]





BTD[8.5-11 μm] (K)

And in conclusion...

Work on separating out overlapping clouds (thin cirrus overlap) from single-layered, mixed-phase clouds

Try to understand some of these regional anomalies that we're seeing

UW Direct Broadcast (DB) system is now operational

Now adapting our MODIS cloud products for DB data

Our intent is to compare MODIS DB cloud products with UW HSRL, Utah FARS, and ARM SGP sites in a routine fashion